Part II: The Beach –A Geologic Marvel in Motion

Bay in the Balance

By DEBORA BABIN KATZ

For most beach-goers, the long sandy shore dividing Duxbury Bay and the Atlantic Ocean is a recreational nirvana accessible by foot, boat and four-wheel drive vehicles. They meander along the beautiful stretch of sand, unload their beach chairs and assorted gear, and sunbathe on these shores, unaware of the amazing case study in barrier systems that lies beneath them; nor do they know that their beach is actually moving.

Our story begins 15,000 years ago when the last New England glaciation, known as the Wisconsinan stage of the Laurentide ice sheet, receded north, and uncovered a new Duxbury. As the ice sheet retreated north, sea levels rose. At the height of ice sheet growth, sea level was approximately 350 feet lower than it is today.

Duxbury Beach is known as a coastal barrier beach because the bay borders on its landward side, and the open ocean is on its seaward side.

Photo by David Grossman

"You could walk out to Georgia's Bank," said Jim O'Connell, a geologist at the Woods Hole Oceanographic Institution and a trustee of the Duxbury Beach Reservation. "Gurnet and Saquish were much bigger than they are today because the sea level hadn't reached and begun to erode these areas."

As the glaciers receded, they left boulders, sand, cobble, and clay behind. Clarks Island, Gurnet and Saquish are drumlins under the glaciers that remained as the ice melted. We know this today because of the extensive boulder plattorm fronting these land forms. If you scuba dive off Duxbury Beach, you will see boulders and gravel left behind as the sand moved landward, said O'Connell.

Duxbury Beach is known as a coastal barrier beach because the bay borders its landward side, and the open ocean is on its seaward side. A barrier island occurs when a coastal barrier detaches from the mainland. When it remains attached to the mainland, it is called a barrier spit. Duxbury Beach is called a tombolo because it is a barrier spit pinned by a land form, and in this case that land form is Gurnet Point.

The barrier beach, however, is in constant motion. Storms accelerate this movement as storm waves carry and deposit sand into the sheltered waters of the bay forming a new beach and dunes on the bay side. This process is known as landward migration. Storms erode the foreshore, the shore face and the backshore, and strong waves break through dunes bringing sand into the bay.

Jim O'Connell, geologist at Woods Hole Oceanographic Institute.

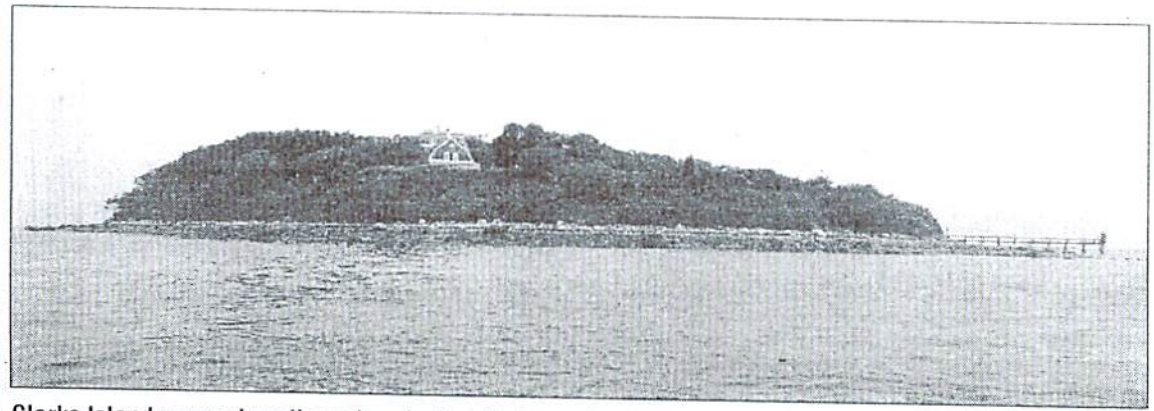
The backshore is where most people sit on the beach. The foreshore is that part extending from the berm out to low waters. The shore face is the seaward-sloping surface that remains submerged except during very low tides.

Storm erosion combined with rising sea levels produces a more marked and rapid movement landward. Past storms, like the infamous Blizzard of 1978 and the storm of 1991, have carried sand from the frontside of the beach to the bay side in what geologist call an "overwash." These storm overwashings have occurred in several locations along Duxbury Beach over the years. They allow sand to wash over and fill marsh and bay areas, thus moving the barrier landward.

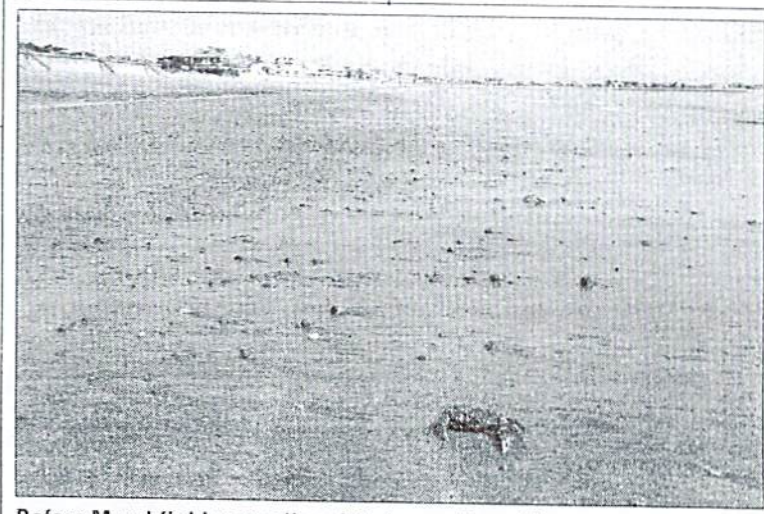
"If you drew a line 2000 to 3000 years ago off the coast of Duxbury, the barrier extended from Howland Ledge off the coast of Marshfield southward," said O'Connell. (See Exhibit I)

Today, the Gurnet is a glacial drumlin holding Duxbury Beach, but this will change as future storms and climate variations impact the migration of this barrier beach. The *International Panel on Climate Change* has predicted that sea level will rise at an accelerated rate in the near future so that the current one-vertical foot in 100 years of sea level increase will almost double over the next 100 years. This scenario of increasing sea level rises combined with future storms will have a huge effect on how Duxbury Beach looks in the future.

"Geologists have predicted that the barrier beach will migrate past Gurnet Point and attach itself to Clarks Island," said O'Connell. "I joke with



Clarks Island was a drumlin under glaciers that remained as the ice melted. *Photo by David Grossman*



Before Marshfield seawalls existed, sand from this area was added to Duxbury Beach, which started from a small sand pit.

Photo by David Grossman

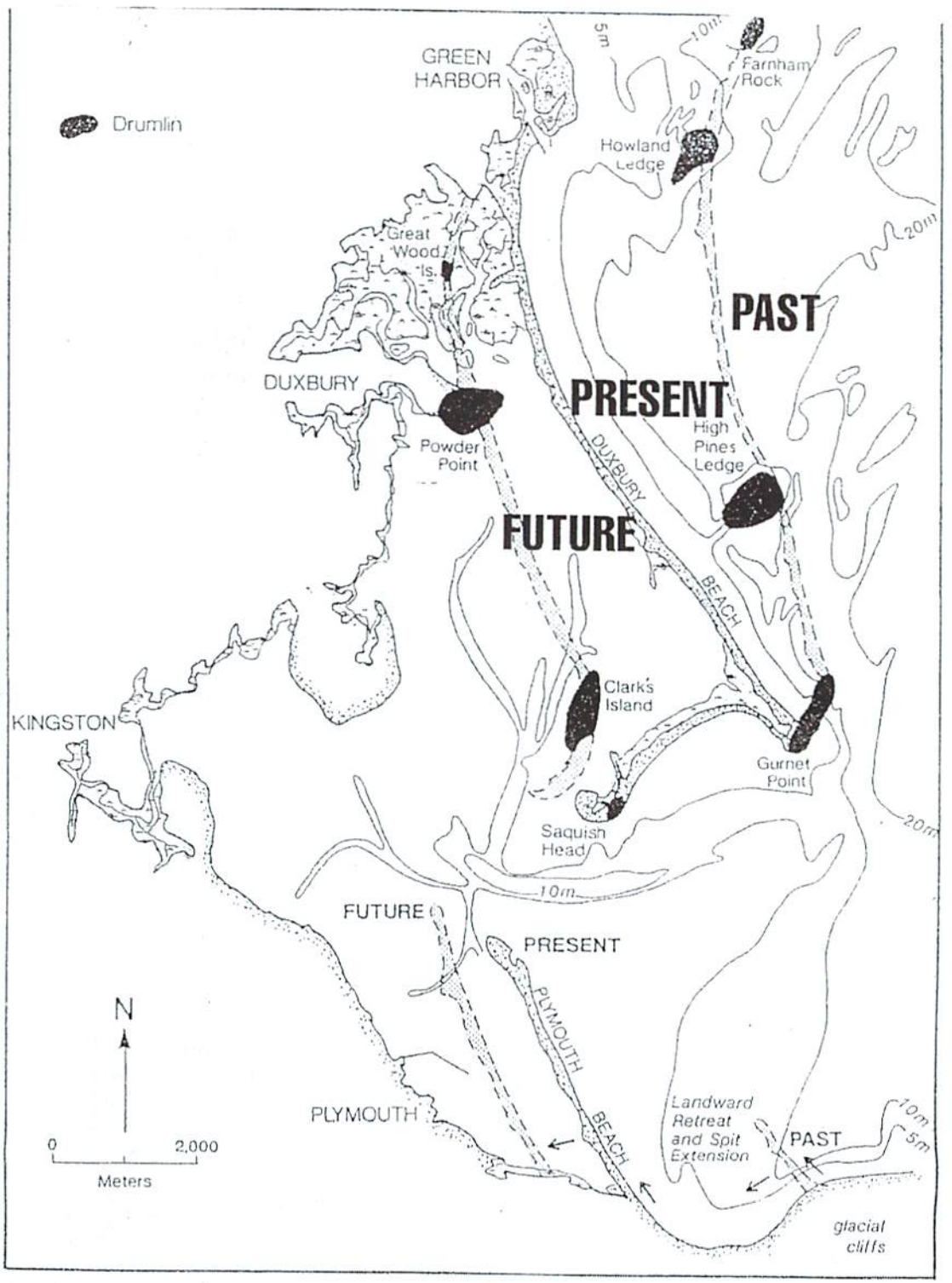
people who own houses out on the Gurnet to start looking into launch services for their great-grandchildren," he said.

The history of Duxbury's barrier movement is seen in comparison studies of navigational charts over periods of years. O'Connell is analyzing shoreline change from the mid-1800s to 1994 along Duxbury Beach. His study found that, in the mid-1800s, the width of the beach near the Powder Point Bridge is the same as it is today but was 150 feet farther into the ocean.

Geologists have also determined that 3,700 years ago Duxbury's barrier was positioned approximately 500 meters offshore. This means Duxbury Bay is actually shrinking.

Another fact adding to the beach's front side erosion is the seawalls along Brant Rock and Marshfield's coastline. "Those coastal areas before the existence of sea walls provided a lot of the sand which created Duxbury Beach, which started as a small spit of sand," said O'Connell.

Several thousands of years ago, the sand began to be added to the small spit, and then about 1,000 years ago, the rate of sea level slowed down and caused significant amounts of sand to be added to the spit. This process made it longer and longer, explained O'Connell.



Evolutionary model of the area showing cyclic barrier progradation and the anchor points for the barriers and spits.

SOURCE: Hill & Fitzgerald, 1992

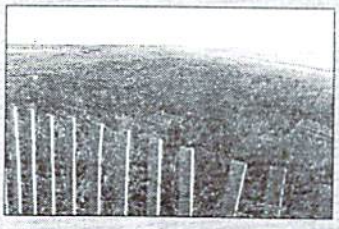
Today, Marshfield's seawalls, built in the 1930s and 40s, have slowed down the sand attaching itself to Duxbury Beach. "By the 1950s, the seawalls were seriously underway which meant that it was not feeding sand to Duxbury Beach," said O'Connell. In essence, solving one problem—the protection of the upland areas in Marshfield—has created a new problem—lack of sand being supplied to Duxbury Beach. "We didn't learn how these sea walls impacted erosion until much later," he added.

Those who return each summer to Duxbury Beach's sandy shoreline and gentle breezes are unaware of its changing size and position. For them, the sights and sounds are familiar. Yet, harsh winter winds and Nor'easters make their mark each year. Constant erosion, the lack of new sand feeding the beach, and rising sea levels will continue to impact this geological marvel. Duxbury Beach is on the move!

Brant Rock, Marshfield. Seawalls built along Brant Rock in Marshfield are adding to Duxbury Beach's front side erosion.

Photo by David Grossman

Bay by the Numbers



115,000

The approximate dollars to repair Duxbury Beach after Hurricane Carol hit in 1954

1,775,000

The total cost paid by the Duxbury Beach Reservation to repair the beach after the Perfect Storm in 1991 and another storm in 1992.

150

The amount paid by the town to buy Duxbury Beach from three individuals in 1832.

3100

The amount paid by Stephen Allen when he bought the beach from the town in 1872.

250

The number of proposed house lots for Duxbury Beach in an 1888 development plan.

2,200

The length in feet of the first Gurnet Bridge completed in 1892.

1,500

Estimated cost in dollars to build first "seawall" in Duxbury in 1832